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ABSTRACT

This study investigated the effects of a minimal manual version versus a cards version of documentation on students' computing behaviors while learning to use a telecommunication system (Appleshare), students' attitudes toward the documentation, and students' later use of the system. Guidelines from the work of Carroll and colleagues at the IBM Watson Research Center and Reder and colleagues from Carnegie Mellon University were followed when developing the two versions of the documentation. Subjects were 74 junior and senior college-level students enrolled in a technical writing course. Results showed that students in both treatments completed the tasks and felt that the documentation was relatively easy to use. There were significant differences, however, in the students' manual/display coordination, in their ratings of the instruction, and in their later use of the system. The central implication of the study is that documentation for computer-based instruction should center on the learners' goals instead of on the system or the concepts being taught. Statistical data is included throughout the report. Sample pages from the minimal manual and the cards version of the documentation, a goal/task checklist for the Appleshare system, and the student questionnaire are appended. (17 references) (Author/GL)

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Computer Documentation: Effects on Students' Computing Behaviors, Attitudes, and Use of Computers

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August, 1989

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Abstract

This study investigated the effects of a minimal manual version versus a cards version of documentation on students' computing behaviors while learning to use a telecommunication system, students' attitudes toward the documentation, and students' later use of the system. Guidelines from the work of Carroll and colleagues at the IBM Watson Research Center and Reder and colleagues from Carnegie Mellon University were followed when developing the two versions of the documentation. Subjects were 74 junior and senior college-level students enrolled in a technical writing course. Results showed that students in both treatments completed the tasks and felt that the documentation was relatively easy to use. There were significant differences, however, in the students' manual/display coordination, in their ratings of the instruction, and in their later use of the system. The central implication of the study is that CBI documentation needs to center on the learner's goals instead of on the system or the concepts that are being taught.

Computer Documentation -- Centering on the Learner

Effective computer programs make learners active participants instead of passive absorbers of the content being studied. Effective computer documentation should also allow learners to create, explore, and integrate knowledge as they use a computer system. While computer programs as a whole are improving, the documentation that accompanies the programs often lags far behind in terms of centering on learners' needs. While many computer programs allow learners to manipulate concepts and to study a myriad of hypothetical situations simultaneously, if learners cannot easily access programs and use them to meet their goals and needs, insight is replaced by frustration. We need good computer programs; we also need good documentation.

In this paper I first discuss the problems that learners have with computer documentation as well as current research on the design and testing of documentation for computer programs. I then describe a study which I conducted on the effects of two new forms of computer documentation on students' ease in learning how to use a telecommunication network.

Computer Documentation -- Problems and Possible Solutions

During the 1980's, researchers at centers such as the Document Design Center in Washington, D.C. (Redish, 1986; Redish, Battison, & Gold, 1985), the Communications Design Center at Carnegie Mellon University (Duffy, Trumble, Isenberg, Janik, & Rodgers, 1987; Schriver, 1984, 1986), and the IBM Watson

Research Center (Carroll & Mack, 1987; Carroll & Rosson, 1985; Carroll, Smith-Kerker, Ford, & Mazur-Rimetz, 1987-88) have studied the problem of training users in the use of computer programs. John M. Carroll and colleagues (1987-88) at the IBM Watson Research Center have broken down the training problem into the following list of user-specific problems which they have seen numerous times:

1. Users are overwhelmed by learning tasks
2. Users jump the gun or plunge into procedures as soon as they are mentioned instead of reading explicit warnings or suggestions
3. Users skip or flip past any information that cannot be directly executed on the screen
4. Users trust their reason and intuition instead of reading documentation
5. Users read a step, carry it out, and then read the next step without checking to see if the step worked on the program
6. Users have trouble recovering from errors because the documentation assumes that users will not make errors
7. Users want to do real work instead of finishing a program and thinking, "What did I do or learn?"

The Minimalist Training Model for Designing Documentation

In response to these problems, Carroll et al. (1987-88) developed and tested what they call a Minimalist Training Model, a model that accommodates and capitalizes on user learning styles and strategies. The three main premises for developing documentation that follows the minimalist training model are to focus on

real tasks and activities, to slash the verbiage, and to support error recognition and recovery.

I will elaborate on these premises as they relate to students' use of the CBI that we develop or their use of the commercially available computer programs that we promote. First, rather than leading students step-by-step through guided practice in using a program, we should allow learners to accomplish real goals or real tasks for which they can use the program. Second, because students will skip over crucial material if it does not meet their immediate task-oriented concerns, we should design documentation that presents key material only once. Third, because we know that students will indeed make errors, we should explicitly help students to recognize errors and recover from them. (We all know the number of times we have turned a computer off because it was our only alternative for error recovery.)

Carroll et al. conducted a series of studies in which they compared minimal manuals to commercially developed self-instruction manuals (1984, 1985, 1987-88). Invariably they have found that minimal manuals help learners better coordinate their attention between the system and the manual, better recognize and recover from errors, and better support reference use after training. Clearly, the minimal manual presents a new concept in terms of how CBI developers might design documentation; it also gives ideas as to how we might revise documentation available with commercial computer programs for more effective use in our classrooms.

Cards as Documentation

In an earlier set of studies, Carroll et al. (1984, 1985) advocated a Guided

Exploration approach. In order to test how users guided their exploration of a computer program, Carroll et al. designed a set of brief cards to replace a commercial self-instruction manual. The cards stressed real user tasks such as "typing something" instead of "practicing with the status line," and the cards contained about an eighth as much verbiage as the original manual.

Results showed that learners who used the cards, as compared to learners who had used the original manual, spent less than half as much time in learning to use the program, spent less than a third as much time reading, made half as many errors, and recovered significantly more often from their errors. Despite the significant differences in favor of the cards version of the documentation, the learners who received the cards expressed a distinct desire for documentation that looked more structured or that had the look and feel of a more traditional manual.

The Role of Textual Elaborations in Documentation

In response to whether computer manuals should be minimalist and contain only information that is absolutely necessary, or maximalist and fully explain unfamiliar concepts and procedures, Reder and colleagues (1984, 1986, 1987) have also researched the optimal design of computer documentation. Specifically, they focused on the informational content of the manuals and on the role of textual elaborations.

They define textual elaborations as "any information that supports, clarifies, or further specifies the main points of a text" (Reder, Charney, & Morgan, 1986, p. 64). Elaborations can take many forms such as examples, details, analogies, restatements, and deductions. An author can include elaborations in the text itself in order to

elaborate on the main ideas or concepts, or the reader can elaborate on the text independently while reading. In either case, elaborations help students learn and remember the main ideas of a text because they help students create more connections to their prior knowledge.

In their investigations, Reder et al. study how users acquire a cognitive skill such as learning how to manipulate files and directories on a computer. In a task such as this, users learn a small set of basic procedures that can be applied to a variety of novel situations. They state that

> good skill performance on a novel task requires three things: (1) Appreciating the meaning of concepts novel to the new skill domain. For example, ... one might be introduced for the first time to function keys that allow the user to reexecute a command that was already issued, without retyping it. (2) Remembering and comparing procedures to select the most appropriate one for the situation at hand. Knowing at some level that such a function key exists does not mean that the user will remember to use it. (3) Remembering the exact syntactic form for the procedure and how to apply it in a specific situation. A user might remember that the typing step could be saved by using the special key but be uncertain as to which of the 10 function keys performs that function and exactly how to apply it (Reder, Charney, & Morgan, p. 66).

Elaborations in computer documentation may do any of the above: they may elaborate on what the basic concepts are, when these concepts are relevant, and how

users apply these to their immediate goals or tasks.

Reder, Charney, and Morgan (1986) investigated the effects of text elaborations on learners' understanding of new concepts and procedures, their actual executing of the procedures, and their recognition as to when each procedure was appropriate for solving a problem. Unlike Carroll's work, Reder et al. incorporated follow-up measures as they believed that the effectiveness of a manual could not be judged by performance during training alone. Their overall results showed that elaborations about executing procedures helped learners solve problems more quickly than minimal manuals that did not include such elaborations. Specifically, they found that syntactic elaborations that illustrated how correct commands should look helped learners determine exactly how to implement a procedure. They concluded that both the minimalist position and the maximalist positions are too extreme and that some elaboration is needed.

As with Carroll and Reder and their colleagues, I have also watched learners become frustrated with learning how to use the computer programs that are expected to aid their learning. Therefore, I conducted an experiment in which I compared the effects of a minimal manual with some elaborations versus a cards version of the manual on students' computing behaviors, their attitudes toward the documentation, and their later use of the computer system.

Method

Subjects

The subjects were 80 junior and senior college-level students enrolled in four sections of a technical writing course titled Writing in Your Profession. Students in this course major in diverse fields such as agriculture, biology, communications, human relations, nutrition, retail merchandising, design, and forestry. All students were enrolled in "computer use" sections of the course which meant that students met two or three times a week in a classroom equipped with 13 Macintosh computers on an Appletalk network. These computers were also connected to the wider university telecommunication network via Appleshare software, and a computer with a 120 megabyte hard disk functioned as the file server.

A total of 74 students completed the study: 38 received a minimal manual with some textual elaborations, and 36 received a cards version of the minimal manual as documentation for using the Appleshare telecommunication system. No significant differences were found among the groups on age, teacher ratings, or previous computer experiences, and no students had previously used a telecommunication system.

Design of the Minimal Manual

A technical communication graduate student and I designed the minimal manual version of the documentation. [1] Carroll et al. (1987-88) emphasize that a minimal manual must be developed iteratively; that is, it should be designed, empirically evaluated, and then redesigned. They also note that in more typical instructional

design practice, testing is done later in the design process, and the usual outcomes of this testing are the addition of further material, qualifications, cautions, and additional explanation. However, in designing a minimal manual, testing enters the process earlier, and instead of adding information to eliminate user problems, the choice should mainly be to cut information.

In designing our minimal manual, we followed Carroll et al.'s three step process by focusing on real tasks and activities, slashing the verbiage, and supporting error recognition and error recovery. We also followed Reder et al.'s suggestions and worked to develop documentation that helped students appreciate the meaning of concepts novel to the new skill domain (in this case, the concept of telecommunications, file servers, volumes, folders, etc.), remember and compare procedures to select the most appropriate one for the task at hand, and remember the exact syntactic forms for the different procedures and how to apply them in specific situations.

We iteratively tested and revised our successive drafts of the documentation. Initial development and pilot testing began during January through March, 1988, with small groups of students and instructors. We also asked a university center that assists faculty in software development projects to evaluate the software and documentation. Follow-up testing occurred during April through May, 1988, with 70 students enrolled in the same technical writing course in which the study was later conducted. In short, we did the following:

Focused on real tasks and activities. In order to involve the student, we labeled sections of the manual with headings such as "Logging on the server," "Identifying

yourself," "Opening the volume," and "Naming files." In earlier testing, we found that students were usually logged on and using the server by page 4 of the documentation. To encourage students to use the server on their own, we included notes, hints, and overviews about how learners might use the server or what to expect or do when common messages (Macintosh or Appleshare system messages) would appear.

Slashed the verbiage. The current AppleShare User's Guide (1987) is 103 pages in length. From this manual we identified only that information that students would need for using the server, and we constructed this information following a bare-bones philosophy. We did not include repetitions, previews, reviews, or practice exercises; we had no index, welcome to telecommunications introduction, or troubleshooting section. Each of our four major sections was organized to be brief so that students could easily move from topic to topic. The manual was six 8 & 1/2" by 11" pages in length.

Supported error recognition and error recovery. In earlier testing of our minimal manual, we inventoried the principal errors of new users. From these notes we developed specific error recovery information by way of notes, warnings, and other information that addressed these common problems. With Appleshare software, the student user must work through a series of four Macintosh windows in order to log on the system. In our earlier testing we found that this succession of windows confused students; they did not know in which part of each window they were to work at any given time. While Carroll et al. would advocate not using any visuals (screen shots) so that learners might better coordinate the actual system display with the description in the manual, our testing indicated that students indeed needed elaborations in this

area. Therefore, we inserted visuals with short textual elaborations in the documentation. Finally, similar to Carroll et al., we inserted clarifying statements that told users what they had just done or how the icons on the screen functioned. The second and third pages of this documentation are included in Appendix A.

Design of the Cards

A second technical communication graduate student and I designed the cards version of the documentation after the development of the minimal manual version. As noted in the introduction, in earlier studies by Carroll et al. (1984, 1985), they designed a set of cards to replace a manual. As in their minimal manuals, their cards documentation focused on user-relevant goals over system-relevant goals, and their cards documentation contained considerably less verbiage than a traditional manual. The cards documentation also stressed error recognition and recovery by breaking down all procedural information into components such as goals, enabling hints, checkpoints and results, and error recoveries.

In designing the set of cards, we began with our minimal manual version. Following Carroll et al.'s iterative design process, we again focused on real tasks and activities, slashed the verbiage, and supported error recognition and error recovery. We used paper clips to hold the sets of seven 8 & 1/2" by 5" cards together. We limited the number of cards to seven because short-term memory can hold a maximum of seven goals or tasks at one time (Miller, 1956).

The cards version of the documentation differed from the minimal manual version in the following ways:

1. Each card represented only one main task or goal, and the number of goals/cards was limited to seven. In the minimal manual version, there were four major headings and thirteen minor headings.

2. Task headings stressed even more strongly real work goals. For example, "Logging on the server" was revised to read, "Getting on the file server," and "Opening the volume" was revised to read "Checking folders and files on the server."

3. While there was very little verbiage in the minimal version, there was even less in the cards version. All visuals (screen shots) of the Macintosh windows/screens were deleted. Thus, the elaborations by way of visuals and short explanations in the minimal manual version were deleted in the cards version.

4. Notes and warning statements were not used. However, goals, hints, checkpoints, and error recovery information were all highlighted in the same manner, that of being in boldface, indented, and with a check mark placed in front of the information.

5. The traditional manual structure was not followed. In Carroll et al.'s (1985) case, their subjects preferred a structured manual. The cards version in this study did not look or feel like a structured manual. The cards were printed on card stock paper and held together by paper clips. All seven headings were in the same typeface and point size. The cards were not numbered but were rather collated in an intuitive order; that is, earlier tasks were placed earlier in the set (e.g., getting on the server, and checking files on the server), and later tasks were placed later in the set (e.g., putting your file on the server, and getting off the server). Two of the cards are included in Appendix B.

Procedures

Four weeks prior to the study, instructors introduced students to the mechanics of using the Macintosh computer and to the software that would be used throughout the quarter (MacWrite, MacPaint, and Courseware for Collaborative Writing software [2]). All students had used the computer to write proposals for feasibility studies, and mechanical difficulties such as starting the computer and opening and using files had been eliminated. Also prior to the study, the instructors met three times with me to learn how to use the Appleshare system, to send messages to all of their students' folders on the file server, and to develop a set of tasks/goals that they wanted their students to accomplish when using the system. The task checklist is included in Appendix C.

On the day of the study, instructors told students that they would be learning how to use the Appleshare system in order to send and receive feedback electronically with their team members and to be able to collaborate without having to meet face-to-face. The file server was likened to a large file cabinet in which students could keep their personal papers/files/folders or in which they could send messages to their instructor or group members. Students were then told that they would be receiving a checklist from their instructor that listed the tasks that they should work to accomplish during the class period. Students were introduced to the three independent observers and were told that these observers would simply be observing their use of the computers.

Students were randomly assigned to one of the two versions of the documentation: the minimal manual version or the cards version. After the five-minute introduction to the study, students were given their individual passwords and were asked to begin.

As with all previous class computer work, students worked in pairs at the machines, and they were told that they were free to ask their instructor or myself any questions they had regarding the use of the system. Students had approximately 40 minutes to use the Appleshare system after which they were each asked to complete a questionnaire about their ease in using the system.

As a follow-up measure, two and three weeks after the study, the file server was checked in order to record how much each student was using the network as a means to communicate with his or her instructor and other group members, or to store his or her own work in a private folder.

Dependent Measures

There were three sets of dependent measures: observations of students' computing behaviors, students' responses to the questionnaire, and the follow-up measure, that of the students' use of the network two and three weeks after the study.

In Carroll et al.'s (1987-88) most recent set of studies, they had independent observers record subjects' ease in completing tasks, the time it took to complete tasks, the number and type of tasks completed, and the number and type of errors that subjects made. For this study, as a measure of the students' ease in using the documentation and the system, three trained independent observers recorded the students' computing behaviors. All observers previously had acted as administrators of Appleshare network systems and were extremely familiar with what should be on a computer screen at any given point in the documentation. Therefore, these observers could easily stand several feet behind the students and be able to record how long

and on which task a pair of students was working.

Specifically, the observers recorded the following:

1. Time spent on each of the six tasks,
2. Number of questions asked (simple tally),
3. Number and type of errors made (these categories were similar to those used by Carroll et al. (1987-88) and included mechanical, manual, window, typing, and miscellaneous errors),
4. A rating as to how well each pair of students was coordinating their use of the documentation with the screen display, and
5. A rating as to how much a pair was enjoying the tasks.

As a measure of students' attitudes toward the documentation and use of the system, each student completed a questionnaire at the end of the class period. The questionnaire was modeled after the suggestions of Selfe (1986) and asked students for quantitative and qualitative data. Specifically, students were asked to respond to the following:

1. their ease in completing the six tasks,
2. their ease in coordinating their attention between the instructions and the screen,
3. their overall rating of the instructions,
4. the percentage of total time that they used the help offered by way of the instructions, the on-screen help, their partner, or their instructor and/or myself,
5. the percentage of their total errors that were attributed to mechanical, instructional, window, typing, or miscellaneous errors,

6. how these instructions compared to other computer instructions they had used in the past,

7. how much they intended on using this system to communicate with their instructor, to collaborate with their group members, and to store their own work in their private folders on the system, and

8. any further comments about the documentation and the system.

A copy of the questionnaire is included in Appendix D.

As a measure of how much students used the telecommunication system following the study, volume reports from the file server were taken two and three weeks after the study. These reports indicated the number of files each student had in his/her private folder.

Results

Computing behavior results of the two treatment groups were analyzed by means of one-way analyses of variance. The means, standard deviations, *F*- and *p*-ratios are presented in Table 1.

Insert Table 1 about here.

As can be seen, the two groups did not differ in the amount of time spent on the six tasks. In fact, time spent on each task was incredibly close across the six tasks in the two treatments. Likewise, students in both treatment groups asked an average of four

questions per pair of students. Considering that none of the students had previously used a telecommunication system, an average of four questions was quite low. The two groups did differ significantly (alpha = .05 or higher), however, in the number of typing and miscellaneous errors. In both cases those students receiving the cards version had more errors, but the total errors in both of the categories -- typing and miscellaneous -- amounted to less than one error per pair of students.

What is especially interesting is the observers' manual/display coordination ratings of the two treatment groups. The mean rating for those students who received the minimal manual version was 2.92 while the mean rating for those students who received the cards was 3.33. This is a significant difference between the two groups, $F(1,73) = 4.06$, $p = .05$. Those students who received the cards appeared to be able to better coordinate their use of the documentation with the screen display. Finally, in terms of enjoyment, both groups seemed to somewhat enjoy the learning tasks.

Students' responses to the circled or checked questionnaire items were analyzed using Chi-Squares. The Chi-Square analyses showed five significant differences between the two groups. Table 2 presents those results that showed significant or nearly significant differences between the two groups.

Insert Table 2 about here.

As can be seen, those students who received the cards version responded more positively to the instruction and use of the system than did those students who received the minimal manual version. Three key questions -- that of the ease in

Table 1

Analyses of Variance on Computing Behavior Results

	Minimal Manual (means)	Cards (means)	$F(1, 36)$	p
Time on Tasks (minutes)				
1. Get on server	6.32	6.45	.04	.83
2. Check folders/files	2.16	2.58	1.62	.21
3. Read a file	4.95	4.30	.97	.33
4. Transfer file from server to disk	6.00	6.22	.06	.81
5. Transfer file from disk to server	8.63	9.90	1.03	.31
6. Get off the server	3.79	4.57	.63	.43
Questions asked (tally)	3.95	4.10	.09	.77
Errors made				
Mechanical	.95	1.50	3.07	.08
Manual	1.05	1.10	.02	.89
Window	1.63	2.05	1.42	.24
Typing	.26	.77	10.12	.002**
Misc.	0	.17	7.85	.006**
Manual/display coordination 1. no coordination 2. slight coordination 3. effort at coordination 4. clear coordination 5. skillful coordination	2.92	3.33	4.06	.05*
Enjoyment of tasks 1. frustrated 2. semi-frustrated 3. somewhat enjoying 4. enjoying the tasks 5. stimulated by the tasks	3.08	3.10	.03	.95

coordinating attention between the instructions and the screen, that of comparing the instructions to other instructions used in the past, and that of using the system in the future -- all showed those students who received the cards version to respond significantly more positively. Specifically, 94% of the students receiving the cards version felt that it was easy to coordinate their attention between the instructions and the screen, while 79% of the students receiving the minimal manual version felt that it was easy to coordinate their attention in this way. Concerning the comparison of these instructions to other instructions they had used in the past, 80% of those students who received the cards version rated these instructions as better, while 50% of those students who received the minimal manual version rated these instructions as better. Concerning how much the students saw themselves using this system to communication with their instructor the remainder of the quarter, both groups responded quite positively: 95% of those students who received the cards version indicated that they planned to use the system some or very much, and 89% of those students who received the minimal manual indicated that they planned to use the system some or very much.

Results on the remaining questionnaire items showed that a majority of students in both groups felt that getting on the server, checking folders on the server, and reading a file on the server were relatively easy or easy tasks. Both groups indicated that they spent roughly equal percentages of time solving errors by consulting the instructions (34% in the cards group vs. 32% in the MM group), on-screen help (16% cards vs. 15% MM), their partner (20% cards vs. 19% MM), or their instructor (30% cards vs. 33% MM). Both groups also indicated that they had roughly equal

Table 2

Students' Responses (percentages) on the Questionnaire Items with Nearly Significant or Significant Differences

		Extremely Difficult	Difficult	Relatively Easy	Easy	X_2	p
How easy was it to --							
Move a file to your disk from the server	MM	13	32	40	16	6.44	.08
	Cards	0	23	54	23		
Put your file on the server	MM	13	29	50	8	8.44	.04*
	Cards	0	15	68	18		
Get off the file server	MM	8	16	45	31	7.42	.05*
	Cards	0	6	37	58		
How easy was it to coordinate your attentionbetween the instructions and the screen?	MM	3	18	76	3	9.41	.03*
	Cards	0	6	71	23		
		poor	OK	good	excellent	X_2	p
How would you rate these instructions?	MM	8	26	58	8	5.45	.10
	Cards	0	14	72	14		
		much better	better	about the same	worse	X_2	p
How do these instructions compare to other computer instructions you've used in the past?	MM	18	32	42	8	10.21	.02*
	Cards	14	66	20	0		
		very much	some	not much		X_2	p
How much do you see yourself using this system to communicate with your instructor the remainder of the quarter?	MM	34	47	19		7.48	.02*
	Cards	17	78	5			

Table 3

Mean Number of Per Student Files on the System Two and Three Weeks After the Study

Treatment		Week 2			Week 3			
			$F(1, 73)$	p			$F(1, 73)$	p
MM	Mean	1.68			Mean	1.90		
	SD	1.07			SD	1.39		
			5.30	.02*			6.61	.01*
Cards	Mean	3.25			Mean	3.33		
	SD	4.06			SD	3.15		

percentages of mechanical errors (9% vs. 6%), instructional errors (29% vs. 33%), window errors (19% vs. 23%), typing errors (12% vs. 9%), and miscellaneous errors (31% vs. 29%). And both groups also indicated that they planned to use the system to communicate with their groups and for their own work.

Perhaps because of the short amount of time (5 minutes) to respond to the questionnaire, only 10 students wrote additional comments (5 students from the cards group and 5 from the MM group). Four students in the cards group wrote positive comments, and one wrote a negative comment; two students in the MM group wrote positive comments, and three wrote negative comments. None of the students receiving the cards version expressed a desire for a more traditionally structured form of documentation.

Students' use of the network two and three weeks after the study was analyzed using a one-way analysis of variance. As can be seen in Table 3, two weeks following

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Insert Table 3 about here.

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the study, those students receiving the cards version had significantly more files in their private folders than did those students receiving the minimal manual version, F (1, 73) = 5.30, p = .02. Three weeks following the study, again those students receiving the cards version had significantly more files in their private folders than did those students receiving the minimal manual version, F (1, 73) = 6.61, p = .02.

Discussion

To summarize the investigation, results from the observers showed that both groups spent equal amounts of time on the six tasks, asked an equal amount of questions, made roughly the same amount of mechanical, manual, and window errors, and appeared to somewhat enjoy learning and using the system. Students in the cards group made more typing and miscellaneous errors, but students in this group also showed better manual/display coordination, a key variable when studying the usability of documentation. Results from the questionnaire indicated that while a majority of the students in both groups felt that all six tasks were relatively easy or easy to complete, students in the cards group felt more comfortable than the minimal manual group with putting a file on the server and getting off the server. Those students receiving the cards version felt significantly more positive concerning the ease of coordinating their attention between the instructions and the screen, these students rated the quality of the cards documentation significantly higher in terms of its comparison to computer instructions they had used in the past, and they felt significantly more positive toward their later use of the system to communicate with their instructor. Results from the follow-up measure substantiated the earlier results in that students who had received the cards version used the system more that did those students who had received the minimal manual version of the documentation.

Students in this study, as all users of documentation, read something in their documentation, saw something on the computer display, and tried to connect, integrate, and interpret the two forms. I want to emphasize that, in this experiment, nearly all students (74 out of 80) in the study were able to complete the six tasks; thus,

both forms of documentation helped students complete the tasks. Additionally, students appreciated both forms of documentation; the differences came in the degree of their positive evaluation. From this I can say that both forms of documentation -- the minimal manual and the cards -- are viable forms for the design and development of CBI documentation. Both forms center on the learner; both forms seek to delete extraneous text.

In terms of the observers' results, the questionnaire, and the follow-up measure, there were differences in how the students connected, integrated, and interpreted the two forms of documentation. As I discuss the differences found in this experiment, I will repeat points noted in the introduction in terms of specific learner/user problems.

First, all students involved in this study had learned how to use the computer for word processing and CAI use; however, they had not used a computer for telecommunications, and, therefore, could easily be overwhelmed by the learning task. Perhaps the clarity of the cards, with one main goal/task per card made the learning task easier and the documentation easier to follow. The clarity of these headings might also have helped students immediately to identify what they were to do or learn. These students could fan out the cards, see a direct parallel between their instructor's tasks and the cards' headings, and proceed. Students using the minimal manual, while using an incredibly minimal version compared to the original User's Guide, still had to skim through 17 headings and subheadings and determine what was most relevant.

Second, with the cards, all information could be directly executed on the screen. Students, therefore, were less apt to skip a step or trust their intuition. The minimal

manual version contained more conceptual elaborations as to the definitions of a server, volume, file, folder, etc., that, while this information elaborated on what the students were actually doing, could not be directly executed on the screen. Likewise, some of the 13 subheadings, while often supplying helpful information (e.g., "naming files"), was also information that was not directly executed on the screen.

Third, because the cards version did not contain visuals (screen shots) of the computer displays, students perhaps were more attentive to coordinating the steps with what appeared on the screen. They were forced to check visually whether a step worked before proceeding on to the next step in the documentation. Even though instructors, administrators, and students in earlier testing had requested such elaborations, in this experiment these visuals did not appear to significantly help the students.

Fourth, in the cards version, all goals, hints, checkpoints, and error recovery information were highlighted in the same manner, that of being in boldface, indented, and with a check mark placed in front of the information. Perhaps this consistency helped students clarify what they were doing and recover from common errors.

This study reinforces the fact that learning is inescapably directed by the learner. The documentation design process followed for this study centered on the learner. Perhaps because the cards version was developed after the minimal manual version, as designers we had even more time to watch learners struggle with the concept and process of telecommunicating. Perhaps because we decided to, as Carroll et al. advocate, slash instead of add information to clarify and control the dissemination of information, our cards version ended up being the absolute minimum form that this

instruction could have taken.

This study also reinforces the fact that in order for learning to take place, it must relate to the goals and methods of the understander, and as such it should be based on functions rather than on a single analysis of features (Schank, Collins, & Hunter, 1986). When we design documentation, we must center on functions rather than concepts, we must think in terms of tasks rather than terms, and we must develop syntactic rather than conceptual elaborations.

Janice Redish, from the Document Design Center in Washington, D.C., invites us to think about computer tutorials as "reading to learn to do" materials. In essence, we are designing documentation that our students use in order to learn to do a task. Redish states that "tutorials work best when users are invited to act rather than to read, when users are involved as active learners, when the tutorial focuses on tasks that are relevant to users" (1988, p. 232). We have learned a great deal about how to design and develop CBI that promotes active learning; our design and development of CBI documentation needs the same degree of learner-emphasis. In designing documentation, we must concentrate on identifying the small set of basic procedures that our learners can apply to a variety of user-relevant tasks.

To conclude, I will quote one of the written comments from a student who received the cards version of the documentation. Because this student was able to learn and to use the software/system, he immediately integrated, immediately recognized how he and others could use the telecommunication system.

> This is great! All instructors in all departments should have this capability! You could explain or ask a question of a chemistry

instructor on another campus or after office hours. The instructor could also put your test grades in your own personal file (private) and leave you words of encouragement or otherwise. He/she could also add things such as mistakes in the syllabus, change test dates, etc. Of course, there must be a reason why they haven't done this yet.

Author Notes

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[2] Courseware for Collaborative Writing (CW_{tm}) was developed by Ann Hill Duin, Mark Stephen DeBower, Linda A. Jorn, and David M. Johnson at the University of Minnesota. It is an integrated package consisting of a tutorial and word processor. It helps students collaboratively plan, draft, revise, and package non-academic documents such as memos, proposals, instructions, short reports, and formal reports.

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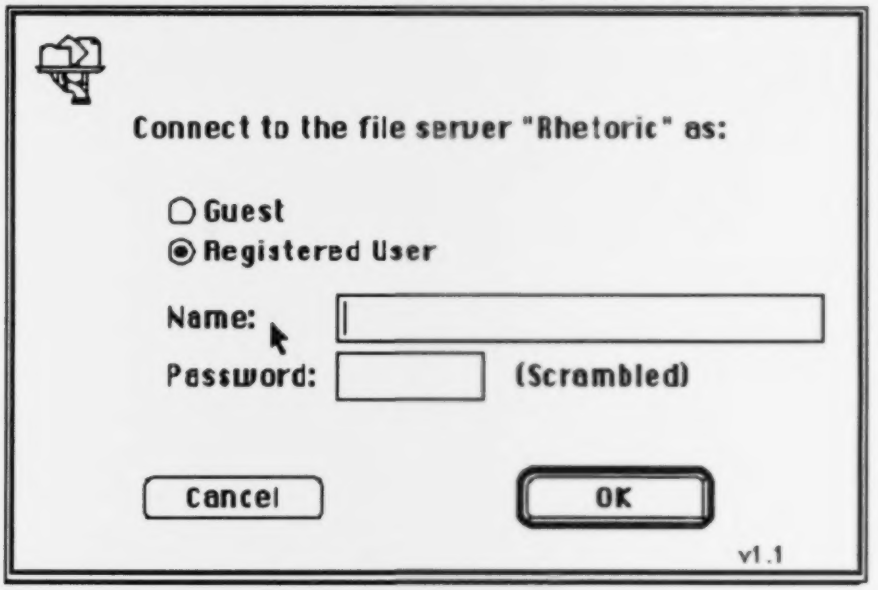
Appendix A. Two Pages from the Minimal Manual Version

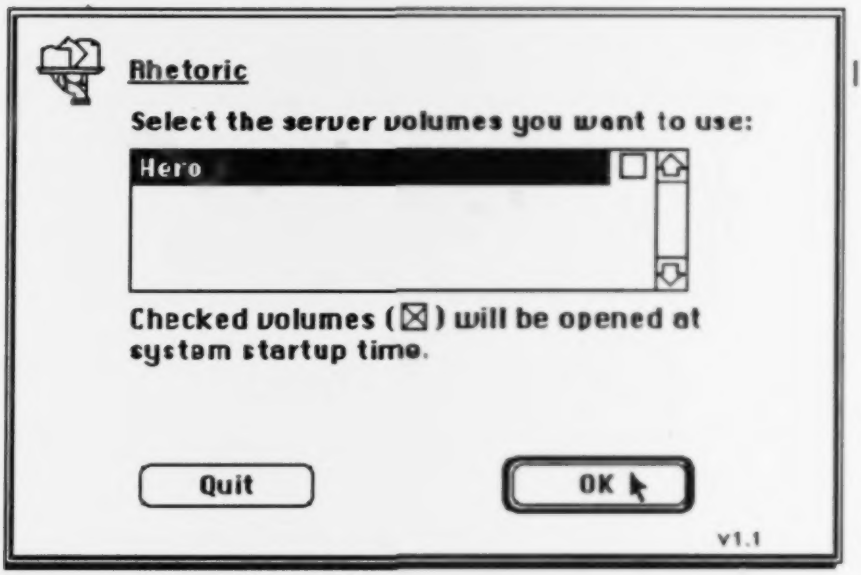
Identifying yourself

1. Type your user name.
2. Press the tab key, and type your password.

NOTE: Type your user name and password exactly as it appears, noting uppercase and lowercase characters. For security, it appears as large dots.



3. Click OK. Note the last dialogue box that appears.



Selecting a volume

4. Click on "Hero" -- the volume you want to use, and then click OK.

   -- **WARNING -- DO NOT** click in the box to the right of the volume.

5. Note the "Hero" icon (shown on the next page). This is the name of the volume used in this class.

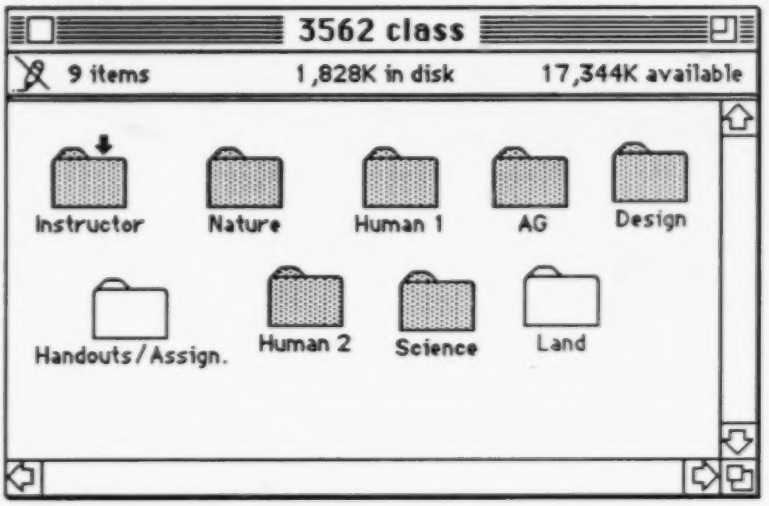
This icon functions just as if you inserted a disk with that name into a disk drive at your computer.

Congratulations! You are now logged on the server!

USING THE SERVER

Opening the Volume

1. Double click on the volume icon labeled "Hero".
2. Double click on the folder labeled "3562 Class".
   Your screen should look similar to that shown below.



3. Note that the folder icons have three different configurations.
   If the folder is --
   - **grey**, you cannot open the folder.
   - **grey, with an arrow pointing to it**, you can drop off files into this folder, but you cannot open and see the contents of the folder.
   - **white**, you can open this folder and may be able to drop off files and drag files to your own disk.

Appendix B. Two Cards from the Cards Version

Getting On the File Server

1 To use the server, insert your System disk in the lower (or internal) disk drive.

2 Pull down the Apple menu and select **Chooser**. In the Chooser dialogue box, make sure AppleTalk is set to **Active** (lower corner of box).

3 Click the AppleTalk Zone named **Rhetoric** (lower left corner).

4 Click the **AppleShare** icon (upper left corner). Click on **Rhetoric** which appeared in the upper right box.

5 Click **OK**. In the new dialogue box, click on **Registered User**, then type your user name. Press the tab key, and then type your password.

√ **If you used the return key instead of the tab, click on the password box and retype your password.**

√ **If you are told your password is invalid, then retype it, taking care to observe upper and lower case letters.**

6 Click **OK**. In the new dialogue box, click on **Hero**--the volume you want to use-- and then click **OK**. You are now logged on the server.

Putting Your File on the Server

1 Insert the disk with the file you want to transfer in the upper (or external) drive. A disk symbol (icon) will appear on the right side of the screen. Double click on this symbol to open the disk.

2 Check that the file you want to put on the server is properly identified. (For example, "ag, proposal, draft", "TB, memo to Ann.")

3 Hold down the clicker on the file you want to move while "dragging" it to the appropriate folder on the server. When the folder turns black, release the clicker. You have now put a copy of your file in the folder.

√ **If you were unable to drop off the file, you do not have access privileges to put files in this particular folder.**

Appendix C. **Goal / Task Checklist -- Appleshare System**

Student(s) _____ Computer # _____

_____

____ **1.** In order to connect to a server so that you can share and receive messages, you need to --

Task: Get on the file server.

____ **2.** In order to see if anyone has left you messages on the server, you need to --

Task: Check folders and files on the server.

_____ **3.** In order to find out what's in a message/file, you need to --

Task: Read a file on the server.

_____ **4.** Your instructor has sent you a message that is in your group folder. Therefore, you need to make a copy of her message on your own disk --

Task: Move a file to your disk from the server.

_____ **5.** Your instructor would like you to send her a previous document that you've written. Drag this document into her Instructor folder. Therefore, you need to --

Task: Put your file on the server.

_____ **6.** Your instructor would like you to spend the rest of classtime responding to the memo she has sent to you. Therefore, you need to --

Task: Get off the file server.

Appendix D. Student Questionnaire

1. How easy was it to --	Extremely Difficult	Difficult	Relatively Easy	Easy
* Get on the file server	1	2	3	4
* Check folders and files on the server	1	2	3	4
* Read a file on the server	1	2	3	4
* Move a file to your disk from the server	1	2	3	4
* Put your file on the server	1	2	3	4
* Get off the file server	1	2	3	4
2. How easy was it to coordinate your attention between the instructions and the screen?	1	2	3	4
3. How would you rate these instructions?	poor	OK	good	excellent

4. What percentage of total time did each of the following help you in solving errors in using the file server?

____ instructions
____ on-screen help
____ partner
____ teacher
100%

5. What percentage of your total errors were each of these types?

____ Mechanical (disks in wrong drive, turning the machine on)
____ Instructional (skipping lines, miscoordinating the instructions and the screen)
____ Window (clicking the wrong item or place in a window)
____ Typing (pressing Return key instead of Tab key, etc.)
____ Miscellaneous (all others)
100%

6. How do these instructions compare to other computer instructions you've used in the past?
___ much better ___ better ___ about the same ___ worse

7. Though you have only just been introduced to the file server, how much do you see yourself using this system during the remainder of the quarter?

* to communicate with the instructor	very much	some	not much
* to collaborate with members of my group	very much	some	not much
* to store my own work (in your private folder)	very much	some	not much

-- Other Comments --